chamber, the antenna forming [which forms] the plasma by inductively coupling radio frequency energy through the dielectric window and into the reaction chamber.

14. (Amended) [An] The oxygen-free plasma etching gas formulation of Claim 1, [for removing an organic ARC on a metallic layer comprising] consisting essentially of one or more fluorine-containing compounds, an optional inert carrier gas and chlorine, the etching gas being free of nitrogen.

--~~16~~. The method of Claim 1, wherein the organic ARC consists essentially of polyimide.

17. The method of Claim 1, wherein the system of etching agents is nitrogen-free.

~~18~~. The method of Claim 1, wherein the plasma generating device is evacuated to a pressure below 40 mTorr while etching the ARC with the etching agents.

~~19~~. The method of Claim ~~11~~, wherein the organic ARC consists essentially of polyimide.

20. The method of Claim 11, wherein the system of etching agents is nitrogen-free.

~~21~~. The method of Claim ~~11~~, wherein the plasma generating device is evacuated to a pressure below 40 mTorr while etching the ARC with the etching agents.

REMARKS

Reconsideration of the April 21, 1999 Official Action is respectfully requested.

The various issues raised in the Official Action are discussed in the order in which they appear in the Official Action.

Applicants reaffirm the election of the invention covered by Claims 1-13. New Claims 16-21 are directed to the elected invention. With respect to Claims 14 and 15, these claims have been made dependent on Claim 1. As such, upon allowance of Claims 1-13 and 16-21, allowance of Claims 14 and 15 is also respectfully requested.

Claims 3, 4 and 10 were rejected under 35 USC §112, second paragraph, for the reasons set forth in paragraphs 6-7, on pages 3-4 of the Official Action. The claims have been amended in a manner which addresses the Examiner's comments. Accordingly, withdrawal of this ground of rejection is respectfully requested.

Claims 1-13 were rejected under 35 USC §102(b) as allegedly being anticipated by U.S. Patent No. 5,514,247 ("Shan"). The reasons for the rejection are set forth in paragraph 9, on pages 4-5 of the Official Action. This rejection is respectfully traversed for the following reasons.

Claim 1 sets forth a process for removing an organic ARC on a metallic layer comprising exposing the ARC to an oxygen-free system of etching agents in an ionized state in a reaction chamber of a plasma generating device, the system of etching agents including one or more fluorine-containing compounds, chlorine and an optional inert carrier gas. The combinations of features recited in Claim 1 and in the claims dependent thereon are not disclosed or suggested by Shan.

As explained in the specification, prior to the invention, the conductive pathways formed by etching a conductive coating were relatively well separated so that some degradation of photoresist could generally be tolerated (specification at page 5, lines 8-10). However, with new generation devices, the conductive pathways are often so close together that even a small amount of degradation can be critical (specification at page 5, lines 10-12). Further, in order to achieve high resolution during exposure and development of deep UV photoresist, the thickness of the photoresist has been reduced from about 12,000Å to around 7,000-8,000Å (specification at page 5, lines 12-15). As a result, less photoresist is available to protect the underlying layers during etching of the ARC (specification page 5, lines 15-16). Figure 2 is a schematic illustration of the results of removing the ARC with a system of agents containing O_2 ionized in a plasma generating chamber, such system while effectively removing the ARC also attacks the photoresist causing general thinning and degradation indicated at points 20 in Figure 2 (specification at page 5, lines 17-21). Such thinning and degradation can cause voids in the conducting pathways or faulty connections leading to errors in the function of the thus produced integrated circuit (specification at page 5, lines 23-26).

Figure 3 illustrates the results of removing the ARC with a system of agents according to the present invention (specification at page 5, lines 27-28). In the process according to the invention, a carrier gas such as an inert, noble gas such as argon can be used and the source of chlorine preferably is chemically pure elemental chlorine

(specification at page 6, lines 3-6). As an example, the process can be carried out with a pressure of about 0.5 to about 500 mTorr, at a temperature of about zero to 100°C with a Cl_2 flow of about 2.5 to about 200 sccm, an inert gas flow of about zero to about 200 sccm, and a fluorine-containing compound gas flow of about 5 to about 200 sccm. In a preferred embodiment, the pressure is about 1 to about 100 mTorr, the temperature is about 30 to 80°C, the Cl_2 flow is about 5 to about 60 sccm, the inert gas is Ar with a flow rate of about 5 to about 80 sccm, and the fluorine containing compound gas is CHF_3 with a flow rate of about 5 to about 80 sccm.

Shan discloses a process for plasma etching a mask patterned dielectric film to form vias on a semiconductor wafer so that the resulting etched structure is devoid of residues on the walls of the structure (Abstract of Shan). According to Shan, the underlying metal when exposed to plasma has a tendency to sputter onto the vertical wall portions of the contact vias structures and the metal-containing sputtered material forms a residue that essentially cannot be removed in the subsequent photoresist stripping process (Abstract of Shan). The plasma etch process according to the Shan invention is stated to enable removal of the sputtered metal by including in the basic dielectric etch gases a gas that reacts with the metal to form volatile compounds that are readily evacuable (Abstract of Shan). However, in the process of Shan, the antireflective coating is a metal coating rather than an organic coating.

According to Shan, the term "metal" is used to refer to aluminum, any other metal film and "any antireflective coating placed thereon" to form conductive interconnecting structures in semiconductor devices (column 3, lines 36-39 of Shan). Shan discloses that a film of aluminum alloy with TiN antireflective coating is deposited upon a substrate and patterned and a dielectric film of silicon dioxide is deposited over the patterned metal layer, the dielectric film being patterned by photoresist lithography to establish patterns which upon etching will establish vias through the dielectric (column 3, lines 45-54 of Shan). Shan discloses that the vias can be etched in a one-step or two-step process, the two-step process including a main etch and an over etch step (column 3, lines 55-58 of Shan). The main etch is designed to etch the dielectric and the metal antireflective coating whereas the over etch step is designed to complete the via-defining process (column 3, lines 60-64 of Shan). The metal-scavenging gas is added during the over etch step (column 3, lines 63-67 of Shan). Accordingly, to the extent that the metal-scavenging gas includes chlorine, it should be clear that the two-step process of Shan fails to disclose or suggest the claimed process wherein chlorine is incorporated in the process for removing an organic ARC.

In addition to the above, it should be clear from the foregoing discussion that Shan relates to a process wherein a metal antireflective coating is etched rather than an organic ARC. Accordingly, Shan fails to disclose or suggest the claimed process (Claims 1 and 11) or the process recited in Claim 16 which recites that the organic ARC consists essentially of

polyimide. Further, Shan discloses that the main etch is carried out with a gas mixture of CHF_3, CF_4, Ar and N_2. In contrast, the oxygen-free system of etching agents recited in Claim 17 is nitrogen-free. Shan also fails to disclose or suggest the combination of features recited in Claim 4 which recites that the system of etching agents consists essentially of CHF_3, Ar and Cl_2. With respect to the pressure in the chamber, Shan discloses that the pressure is 50 to 300 mTorr and the example in column 5 of Shan is carried out at 250 mTorr pressure for the main etch and the over etch. In contrast, Claim 18 sets forth that the plasma generating device is evacuated to a pressure below 40 mTorr while etching the ARC with the etching agents.

In summary, Shan relates to a process of etching a substrate having a metal antireflective coating whereas the claimed process relates to removal of an organic ARC. In addition, the system of etching agents according to the invention can be nitrogen-free whereas nitrogen is required in the etching chemistry of Shan. The etching process according to the invention can be carried out at a pressure below 40 mTorr whereas the minimum pressure disclosed in Shan is 50 mTorr. Accordingly, the claimed process is clearly patentable over Shan.

It is submitted that the differences between the claimed subject matter and the prior art are such that the claimed subject matter, as a whole, would not have been obvious at the time the invention was made to a person having ordinary skill in the art.

In view of the foregoing, it is submitted that the present application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

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Date: July 21, 1999